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REMOVAL OF PLUTONIUM-CONTAMINATED SOIL FROM THE  
903 LIP AREA DURING  
1976 AND 1978

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**CONTENTS**

<b>Abstract</b>	<b>1</b>
<b>Introduction</b>	<b>1</b>
<b>History of the Plutonium-Contaminated Oil Drum Storage Area (903 Area)</b>	<b>1</b>
<b>History of the Plutonium-Contaminated 903 Lip Area</b>	<b>2</b>
<b>Soil Removal Project - Summer 1976</b>	<b>4</b>
<b>Soil Removal Project - Summer 1978</b>	<b>4</b>
<b>Conclusions</b>	<b>7</b>

# REMOVAL OF PLUTONIUM-CONTAMINATED SOIL FROM THE 903 LIP AREA DURING 1976 AND 1978

*C J Barker*

## ABSTRACT

This report describes the removal of plutonium contaminated soil from the 903 Lip Area at the Rocky Flats Plant Golden Colorado. The report includes the history of the contamination development work associated with planning soil removal descriptions of the work performed using two different methods of soil removal and data indicating that the soil removal was conducted with no adverse impact on the environment.

This report documents the efforts involved in planning and performing the cleanup with no adverse environmental impact.

## HISTORY OF THE PLUTONIUM-CONTAMINATED OIL DRUM STORAGE AREA (903 AREA)

From the beginning of plutonium operations at the Rocky Flats Plant in May 1953 organic liquids contaminated with plutonium have been generated in various manufacturing operations. Processes for recovering plutonium from these liquids (mainly the coolant oils) were not developed until 1967.

## INTRODUCTION

The Rocky Flats Plant is a Department of Energy (DOE) facility involved in the fabrication of nuclear weapons components. The Plant established in 1951 is operated for the DOE by the Energy Systems Group of Rockwell International.

An extensive environmental control and surveillance program is conducted at the Plant by the Environmental Sciences branch of the Health, Safety and Environment department. The program is designed to ensure that safeguards at the Plant keep the release of radioactive and toxic materials within the DOE concept of "As Low As Practicable (ALAP) "

As part of the effort to meet the ALAP criteria the Rocky Flats Plant has an ongoing program designed to clean up previously contaminated areas at the site. An example of the program occurred during the summers of 1976 and 1978 when plutonium-contaminated soil was removed from an area designated as the 903 Lip Area. This area is adjacent to a portion of the Plant formerly known as the Oil Drum Storage Area. These two areas are shown in Figure 1.

In July 1958 an outside oil drum storage field was established and during subsequent years, drums containing plutonium-contaminated machining oils were continually added to the storage area. Drum leakage was first discovered in the storage area in 1959. From that time on to minimize corrosion a rust inhibitor (ethanolamine) was added to all drums prior to storage. Despite that preventative action evidence of drum deterioration and soil contamination was found in 1964. Work was accelerated toward developing processes and equipment that would recover plutonium contained in the drum-stored oils. In January 1967, removal of the drums from the storage area began, and by June 1968 the last drum had been removed to a processing facility. In 1969 fill material and soil sterilant were applied to the drum storage field and by November of that year an asphalt containment cover (shown in Figure 1) was completed. \* It is believed that those work activities plus high

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\* This area is often referred to as the (asphalt) pad area.

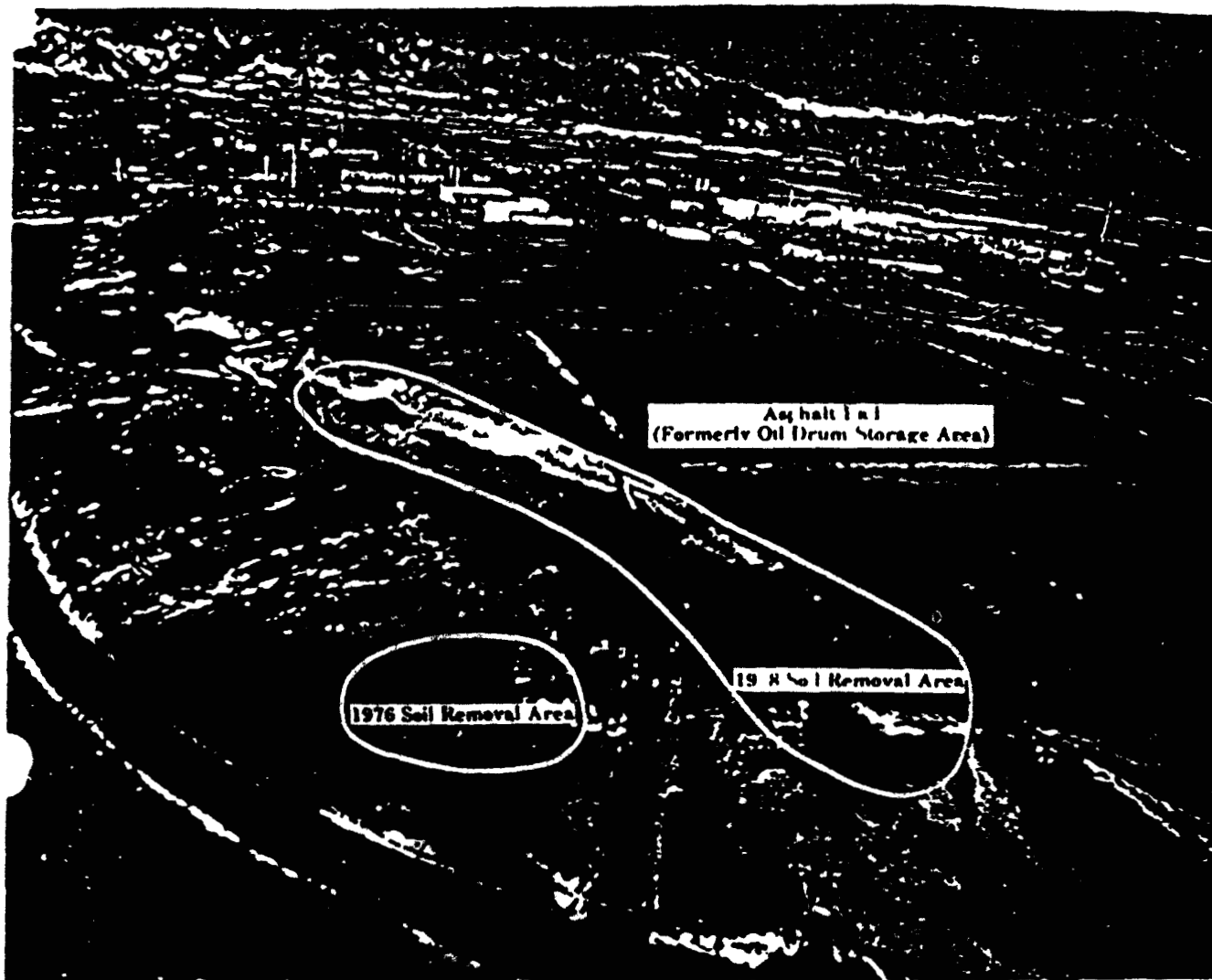


FIGURE 1 Soil Removal Areas

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winds predominately from the northwest contributed to the spread of radioactivity to adjacent areas. One of these areas is called the 903 Lip Area, which is immediately southeast of the drum storage field. As shown in Figure 2, measured concentrations of total long lived alpha activity at Air Sampler S 7 (east of the drum storage field) increased during the time of these activities.

It is estimated that the amount of plutonium deposited in the drum storage area was 0.3 curies, that total an estimated one curie of plutonium

was redistributed beyond the pad area and of that one curie 0.56 curie is believed to have been deposited in the 903 Lip Area.

#### HISTORY OF THE PLUTONIUM-CONTAMINATED 903 LIP AREA

Surveys at the time of the drum removal project and subsequent annual soil sampling showed a maximum plutonium concentration of 5,680 f/m<sup>2</sup> (558 pCi/g) in the top 5 cm of soil in the 903 Lip Area. In June 1977, an aerial radiological monitoring survey (ARMS) by EC&G Inc., Las Vegas, Nevada, indicated that contamination was present in the area rather than in isolated spots.

Air Sampler S 7  
located S 7

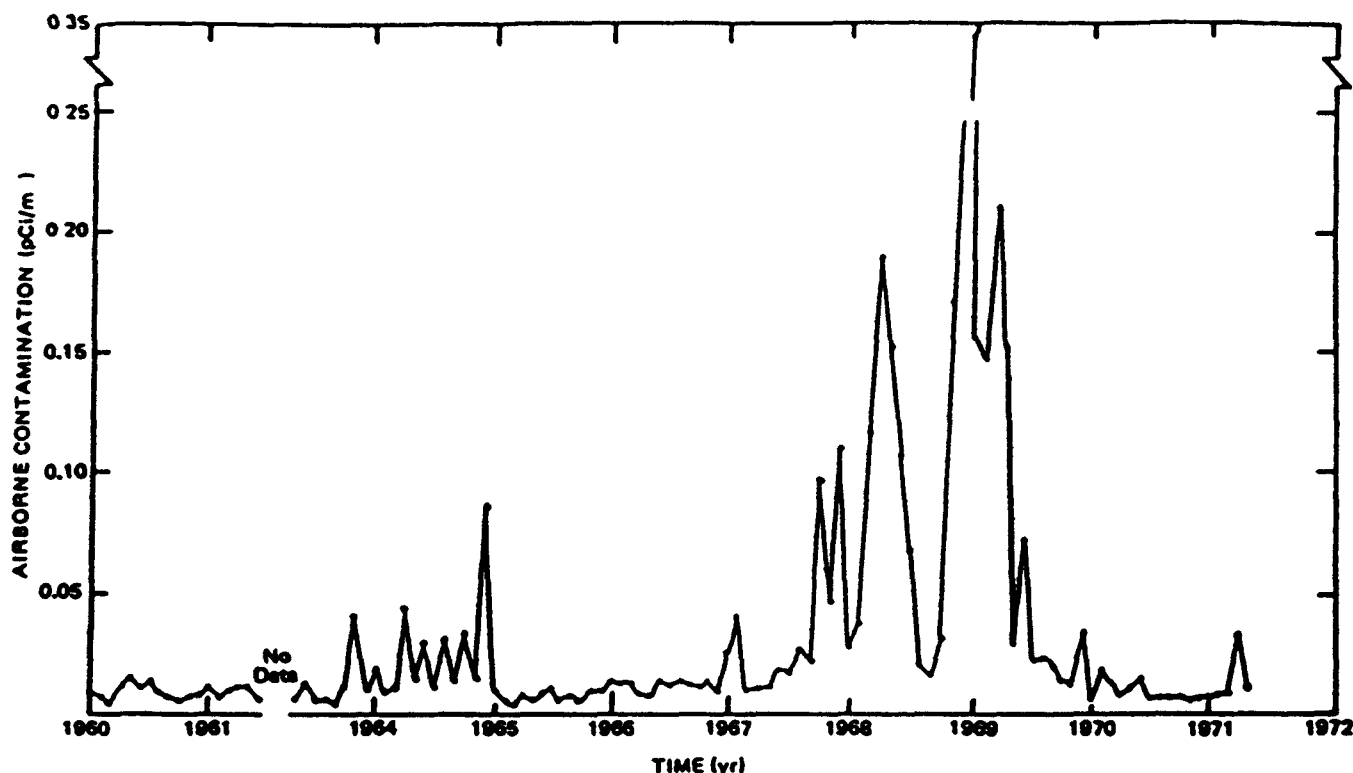


FIGURE 2. Total Long-Lived Alpha Concentrations From Air Sampler S-7 East of the Drum Storage Area. Sampler S-7 was formerly identified as Sampler S-8

Personnel from the ERDA Health and Safety Laboratory (now DOE Environmental Measurements Laboratory) conducted a soil sampling effort and direct reading surveys (using a FIDLER, which is a field instrument for detecting low energy radiation). These two simultaneous surveys confirmed the ARMS indications.

In February 1974 a public briefing was held at the Rocky Flats Plant for the Governor of the State of Colorado and other State officials. During that briefing and in subsequent press releases, ERDA (now DOE) made a commitment to further stabilize or remove the contaminated soil in the 903 Lip Area.

A practice soil excavation to help develop an effective removal technique was performed on May 5 1975 in an uncontaminated area about 350 m northwest of the contaminated area

On May 13 and 14 1975 personnel from the Health and Safety Laboratory with the aid of

Rocky Flats personnel, excavated two trenches in the contaminated area. The techniques used were those developed in the practice excavation. Eight 55-gal drums of contaminated soil were removed from the two trenches. Subsequent analysis of high-volume air samples taken during the excavation process indicated a plutonium concentration of  $0.00258 \text{ pCi/m}^3$ . This value was fairly consistent with the range of annual averages for routine air samplers located in the same general vicinity. At that time, those samplers ranged from concentrations of  $0.001$  to  $0.003 \text{ pCi/m}^3$ . The DOE Radioactivity Concentration Guide (RCG) for soluble plutonium in ambient air accessible to incidentally exposed individuals is  $0.06 \text{ pCi/m}^3$ . It was concluded that the excavation work in the contaminated 903 Lip Area had created no hazardous conditions for either industrial workers or the off-site population. Also no adverse environmental impact was created. Based on these conclusions, a plan for removing the plutonium contamination from the entire 903 Lip Area was decided upon and work began in the summer of 1976.

## SOIL REMOVAL PROJECT - SUMMER 1976

An Environmental Assessment for removing plutonium-contaminated soil from the 903 Lip Area was distributed on June 1 1976 and soil removal began on June 28. The procedure to be used during soil removal was detailed in the document and was based on the technique used by Health and Safety Laboratory personnel during the trench excavation in May 1975.

All personnel involved in excavation and packaging of the soil were provided with protective clothing and respiratory equipment to protect against inhalation ingestion and body contamination. Personnel were required to shower and change clothing at the end of each work shift and all workers were provided full radiation monitoring and dosimetry services as appropriate.

The primary control for possible resuspension of contamination was an 8' X 16' floorless metal building that was equipped with a door window high efficiency particulate air (HEPA) filter and a vacuum mover. This building isolated the immediate digging area and was moved as required.

A plywood walkway was installed between the digging site and the adjacent roadway to provide access to the contaminated area. The walkway was used for personnel and equipment access and for removal of soil from the area. It was periodically checked for any spread of contamination.

Dust palliatives such as water and/or soil stabilizer spray were used periodically to control resuspension of soil during and after the operation.

A portable low-volume air sampler (2 cfm) was located inside the building, and portable high-volume (40 cfm) samplers were run outside the building at probable downwind locations. Operations were halted if persistent wind speeds over 24 km/hr (15 mph) were measured.

Contaminated soil was hand-excavated from one small area at a time and placed in plastic bags.

The bags were monitored before being removed from the environmental protection building. The bags were then placed in plastic lined 4 X 4 X 7'

boxes for shipment offsite. Next the excavated area was resurveyed with a FIDLER. This entire process was continued until contamination levels were below the detectability limit of the FIDLER (~250 counts per minute in the lip area). Each excavated area was covered with clean top soil and reseeded with native grasses.

The 1976 soil removal operation was terminated on September 9 1976. A total of 35 boxes weighing approximately 125 000 lb had been removed and shipped offsite at an approximate cost of \$44 000. There were no personnel exposures and air sampling data indicated there was no adverse environmental impact. Figure 3 shows annual average plutonium concentrations for the three routine high-volume (40 cfm) ambient air samplers located in the areas most likely to be influenced by any resuspension of contamination from the 903 Lip Area.

## SOIL REMOVAL PROJECT - SUMMER 1978

Reviews conducted after completion of the 1976 soil removal project indicated that while the technique used was safe it was inefficient when comparing time consumed versus the large amount of contaminated soil still requiring removal from the 903 Lip Area.

New techniques for soil removal with mechanized equipment were developed and meetings to discuss the new techniques were held with Colorado Department of Health (CDH) personnel. Practice sessions using the new techniques were performed for DOE and CDH observers during the summer of 1977.

In April 1978 a Rocky Flats Operational Safety Analysis was written for contaminated soil removal using these techniques. Soil removal in the 903 Lip Area using the new techniques, began on June 27 1978. The procedure involved use of a front end loader alone or in conjunction with a road maintainer and/or dozer. Hand digging was done in any area where mechanized equipment could not be used.

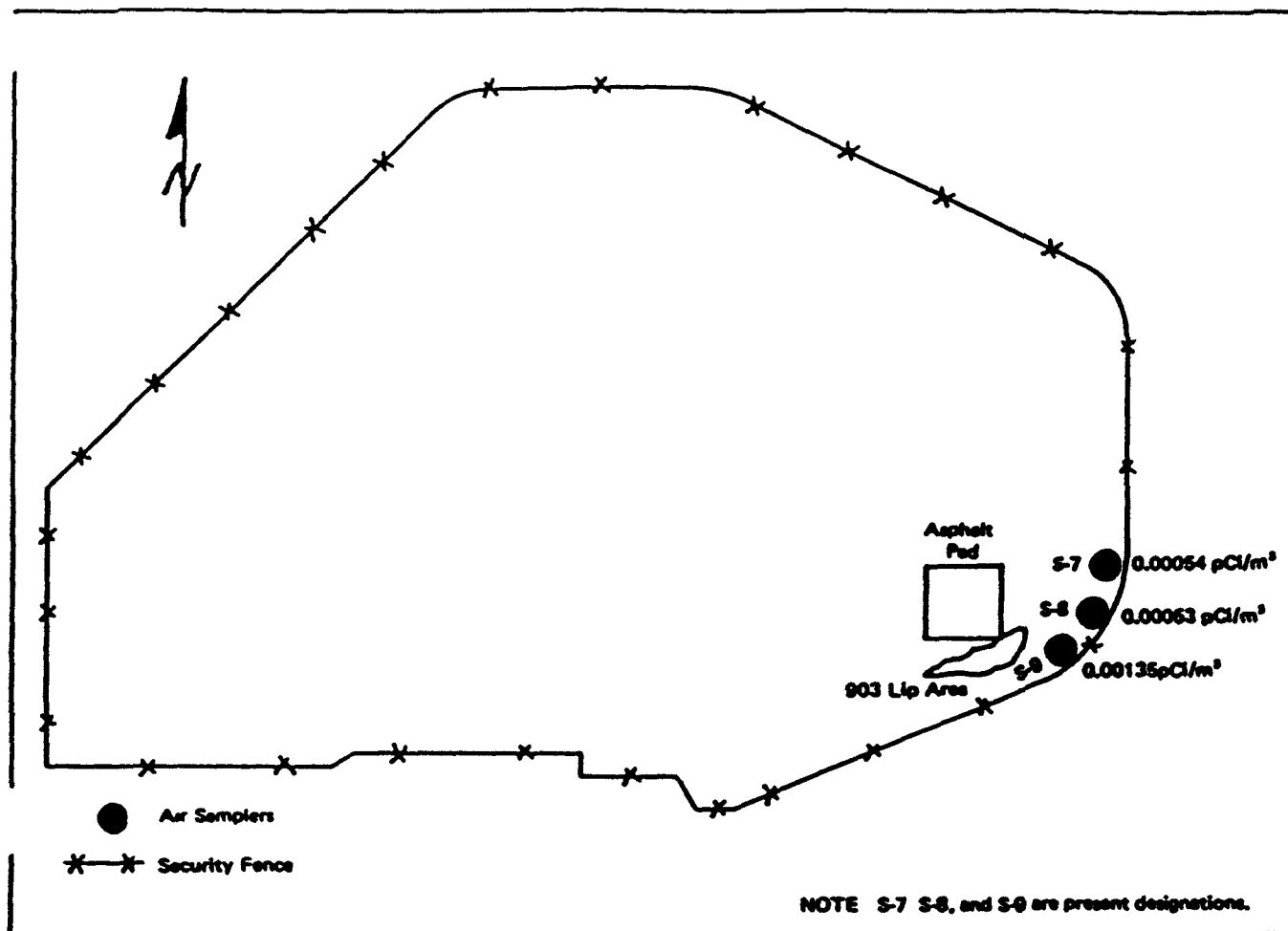


FIGURE 3 Annual Average Plutonium Concentrations in 1976 for Ambient Air Samplers Located Near 903 Lip Area During Soil Removal

Prior to starting soil removal the area to be excavated was premoistened by a sprinkler system for three days. A moisture content of approximately 15% was required. Water was available at all times for sprinkling on an "as required" basis.

Personnel restrictions regarding protective clothing and respiratory equipment remained the same as those used for the hand digging method. At least three portable high-volume ambient air samplers were operated at all times that work was in progress.

A Rocky Flats Environmental Sciences representative was in the 903 Lip Area during all operations with authority to terminate the work if any of the following events occurred:

1. Wind speeds in excess of 24 km/hr (15 mph)
2. Any visible dust, or any indication that area sprinkling was inadequate
3. Total long-lived alpha concentrations greater than 0.06 pCi/m³ as measured on filters from the portable ambient air samplers.

All contaminated soil was loaded into plastic-lined 2' X 4' X 7' plywood boxes for offsite shipment. All boxes were sealed, nailed, and transported to locked fenced storage and were steel-banded before the end of each work day. The boxes subsequently were shipped by truck to the Nevada Test Site for storage.

II soil in the 903 Lip Area that exceeded 2000 counts per minute as determined by a FIDLER was removed. Cleaned areas were resurveyed and soil removal was continued until background (approximately 250 counts per minute by FIDLER for these particular areas) readings were obtained.

Contaminated soil removal from the 903 Lip Area was completed on October 13, 1978. Topsoil was applied to the entire excavated area and the area was reseeded with native grasses.

During the 1978 phase of this project, a total of 1448 boxes weighing approximately 4.7 million pounds were removed and shipped offsite at an approximate cost of \$410,000. There were no personnel exposures and air sampling data indicated no adverse environmental impact. Table I shows total long-lived alpha data from the portable ambient air samplers. Samplers 1-3 were operated only during periods when excavation was taking place. Sampler 4 operated continuously. If after 48 hr a sampler exceeded the action level of 0.02

TABLE I Total Long Lived Alpha Concentrations From Portable Air Samplers During Lip Area Soil Removal (June 27-October 13, 1978)

Date	Sampler No. 1		Sampler No. 2		Sampler No. 3		Sampler No. 4	
	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )
6-28-78	0.627	0.033	1.017	0.034	0.092	0.027	< 0.001	-
6-30-78	< 0.001	-	< 0.001	-	0.008	-	< 0.001	-
7-05-78	< 0.001	-	0.106	0.023	< 0.001	-	0.055	0.022
7-06-78	0.095	0.109	0.188	0.130*	< 0.001	-	0.021	0.009
7-07-78	0.029	0.037	< 0.001	-	0.029	0.034	< 0.001	-
7-10-78	0.116	< 0.001	0.174	0.038	< 0.001	-	< 0.001	-
7-11-78	-	-	-	-	-	-	0.046	< 0.001
7-12-78	-	-	-	-	-	-	< 0.001	-
7-13-78	< 0.001	-	-	-	-	-	0.019	0.002
7-14-78	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	-
7-17-78	-	-	-	-	-	-	< 0.001	-
7-18-78	-	-	-	-	-	-	0.046	< 0.001
7-19-78	0.138	0.019	0.545	0.795	0.079	0.022	< 0.001	-
7-20-78	0.031	0.026	-	-	0.020	0.027	0.019	0.014
7-21-78	< 0.001	-	0.008	-	0.008	-	0.003	-
7-24-78	0.088	0.046	< 0.001	-	0.029	0.014	0.004	-
7-25-78	-	-	-	-	-	-	0.005	-
7-26-78	< 0.001	-	< 0.001	-	0.004	-	< 0.001	-
7-27-78	-	-	-	-	-	-	< 0.001	-
7-31-78	0.021	< 0.001	< 0.001	-	< 0.001	-	-	-
8-01-78	0.067	0.038	< 0.001	-	< 0.001	-	-	-
8-02-78	0.064	0.002	< 0.001	-	< 0.001	-	0.005	-
8-03-78	-	-	-	-	-	-	0.045	0.013
8-04-78	-	-	-	-	-	-	0.006	-
8-07-78	< 0.001	-	< 0.001	-	0.159	0.035	0.003	-
8-08-78	0.335	< 0.001	0.239	0.019	0.001	-	0.031	< 0.001
8-09-78	< 0.001	-	0.002	-	< 0.001	-	0.007	-
8-10-78	-	-	-	-	-	-	0.004	-
8-11-78	< 0.001	-	0.018	< 0.001	0.045	0.007	< 0.001	-
8-14-78	-	-	-	-	-	-	0.008	-
8-15-78	-	-	-	-	-	-	< 0.001	-
8-16-78	0.216	0.218*	0.028	0.018	0.028	0.041	0.061	< 0.001
8-17-78	0.031	< 0.001	< 0.001	-	< 0.001	-	0.007	-
8-18-78	-	-	-	-	-	-	0.014	0.018
8-21-78	-	-	-	-	-	-	0.023	0.068

Exceeds automatic shutdown level of 0.06 pCi/m (72-hr count).

continued

TABLE 1 (Concluded)

Date	Sampler No. 1		Sampler No. 2		Sampler No. 3		Sampler No. 4	
	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )	48-hr Count (pCi/m <sup>3</sup> )	72-hr Count (pCi/m <sup>3</sup> )
8-22-78	0.338	0.254	0.045	< 0.001	0.039	< 0.001	0.034	0.049
8-23-78	0.402	0.09	< 0.001	-	0.046	0.04	< 0.001	-
8-24-78	0.195	0.096	< 0.001	-	< 0.001	-	-	-
8-25-78	-	-	-	-	-	-	-	-
8-28-78	0.085	0.036	< 0.001	-	0.036	< 0.001	0.028	0.006
8-29-78	< 0.001	-	< 0.001	-	< 0.001	-	0.064	0.038
8-30-78	< 0.001	-	0.067	< 0.001	0.039	< 0.001	0.088	< 0.001
8-31-78	< 0.001	-	< 0.001	-	0.008	-	0.024	< 0.001
9-01-78	-	-	-	-	-	-	0.007	-
9-05-78	< 0.001	-	< 0.001	-	< 0.001	-	0.008	-
9-06-78	0.208	0.063	< 0.001	-	< 0.001	-	0.078	0.013
9-07-78	-	-	-	-	-	-	0.007	-
9-08-78	-	-	-	-	-	-	< 0.001	-
9-11-78	-	-	-	-	-	-	< 0.001	-
9-12-78	< 0.001	-	< 0.001	-	0.103	0.019	0.041	0.004
9-13-78	< 0.001	-	< 0.001	-	< 0.001	-	0.075	0.014
9-14-78	-	-	-	-	-	-	0.047	0.001
9-15-78	-	-	-	-	-	-	0.618	< 0.001
9-18-78	-	-	-	-	-	-	< 0.001	-
9-19-78	-	-	-	-	-	-	< 0.001	-
9-20-78	-	-	-	-	-	-	< 0.001	-
9-21-78	0.077	0.007	0.026	< 0.001	0.037	< 0.001	< 0.001	-
9-22-78	-	-	-	-	-	-	< 0.001	-
9-25-78	-	-	-	-	-	-	< 0.001	-
9-26-78	0.005	-	< 0.001	-	0.002	-	< 0.001	-
9-27-78	< 0.001	-	< 0.001	-	< 0.001	-	< 0.001	-
10-03-78	0.232	0.007	< 0.001	-	< 0.001	-	0.053	0.007
10-04-78	-	-	-	-	-	-	< 0.001	-
10-05-78	-	-	-	-	-	-	< 0.001	-
10-06-78	0.001	-	0.027	0.003	< 0.001	-	0.007	-
10-09-78	-	-	-	-	-	-	0.008	-
10-10-78	0.038	0.004	< 0.001	-	< 0.001	-	-	-
10-11-78	-	-	-	-	-	-	< 0.001	-
10-12-78	-	-	-	-	-	-	0.002	-
10-13-78	0.005	-	< 0.001	-	< 0.001	-	-	-

Exceeds automatic shutdown level of 0.06 pCi/m<sup>3</sup> (72-hr count).

pCi/m<sup>3</sup> another measurement would be made after 72 hr. A 72-hr measurement of  $\geq 0.06$  pCi/m<sup>3</sup> resulted in an automatic shutdown of activity.

Table 2 shows the monthly average plutonium concentrations for the three routine high volume ambient air samplers located in the areas most likely to be influenced by any resuspension of contamination from the soil removal project. Concentrations at these samplers remained within ranges normally expected considering the effects of two atmospheric nuclear weapons tests conducted by the

People's Republic of China during the same time period.

Table 3 shows annual average plutonium concentrations for the same three ambient air samplers over a five-year period.

## CONCLUSIONS

Approximately 0.5 curie of plutonium was removed from the 903 Lip Area through extensive soil removal activities conducted during the summers of

**TABLE 2 Monthly Average Plutonium Concentrations for Ambient Air Samplers Located Near 903 Lip Area Soil Removal**

1978	Sampler 7 (pCi/m <sup>3</sup> )	Sampler 8 (pCi/m <sup>3</sup> )	Sampler 9 (pCi/m <sup>3</sup> )
January	0.00021	0.00261	0.00110
February	0.00013	0.00020	0.00030
March	0.00018	0.00022	0.00044
April	0.00054	0.00077	0.00129
May	0.00015	0.00025	0.00029
June	0.00014	0.00004	0.00031
July	0.00024	0.00045	0.00096
August	0.00042	0.00049	0.00087
September	0.00039	0.00054	0.00061
October	0.00026	0.00060	0.00090
November	0.00012	0.00068	0.00123
December	0.00033	0.00177	0.00164

NOTE The Radioactivity Concentration Guide (RCG) for soluble plutonium in ambient air accessible to incidentally exposed individuals is 0.06 pCi/m<sup>3</sup>

1976 and 1978 This quantity is based on an average concentration of 1200 d/m/g of plutonium contamination in soil and a density of 1 g/cm<sup>3</sup>

Two completely different methods of removing contaminated soil were implemented during this extensive cleanup project. Both methods proved to be safe for personnel involved in the project and both methods were employed with no adverse

**TABLE 3 Annual Averages of Plutonium Concentrations for Ambient Air Samplers Located Near 903 Lip Area**

Year	Sampler 7 (pCi/m <sup>3</sup> )	Sampler 8 (pCi/m <sup>3</sup> )	Sampler 9 (pCi/m <sup>3</sup> )
1974	0.00084	0.00317	0.00051
1975	0.00057	0.00046	0.00049
1976	0.00054	0.00053	0.00135
1977	0.00024	0.00053	0.00059
1978	0.00028	0.00069	0.00086

NOTE The Radioactivity Concentration Guide (RCG) for soluble plutonium in ambient air accessible to incidentally exposed individuals is 0.06 pCi/m<sup>3</sup>

environmental impact The technique used during the summer of 1976 proved to be inefficient however An entire summer of hand digging in a floorless building yielded a total of 35 boxes of contaminated soil which were removed at an approximate cost of \$44 000 or \$1 257.14 per box Use of mechanized equipment during the summer of 1978 yielded a total of 1 448 boxes of contaminated soil These boxes were removed at an approximate cost of \$410 000 or \$283.15 per box

Future soil removal projects at the Rocky Flats Plant will incorporate the use of mechanized equipment with hand digging implemented only for isolated small areas or in areas where the use of mechanized equipment is not feasible

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503 LP AREA DURING  
1975 AND 1973



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